Dropsim gives new insight into operational limits of freefall lifeboats

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Set-up for drop tests in the Depressurised Wave Basin

With the successful validation of the software tool Dropsim a significant step forward has been made in determining the operational boundaries related to sailaway of freefall lifeboats.

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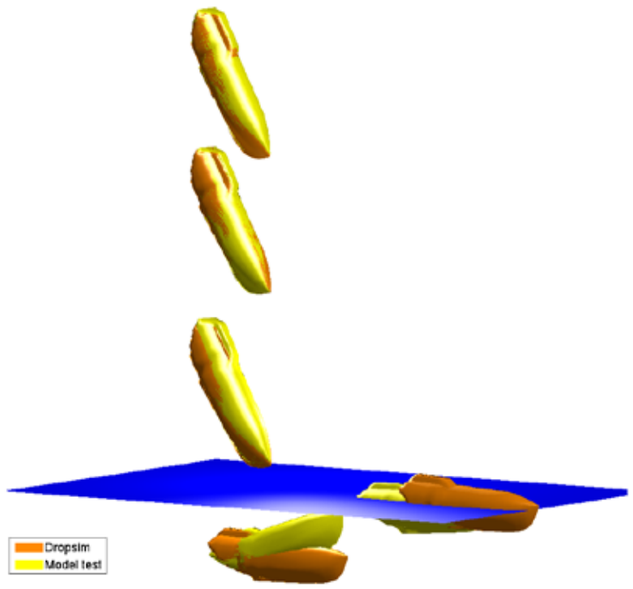
For the oil industry, the safety of personnel is an overriding concern. If helicopters cannot be used to evacuate people, freefall lifeboats will generally be the main (and only) alternative for emergency evacuation. A crucial challenge is to demonstrate and document that such an evacuation can be conducted safely, with no significant harm to the personnel on board the lifeboat.

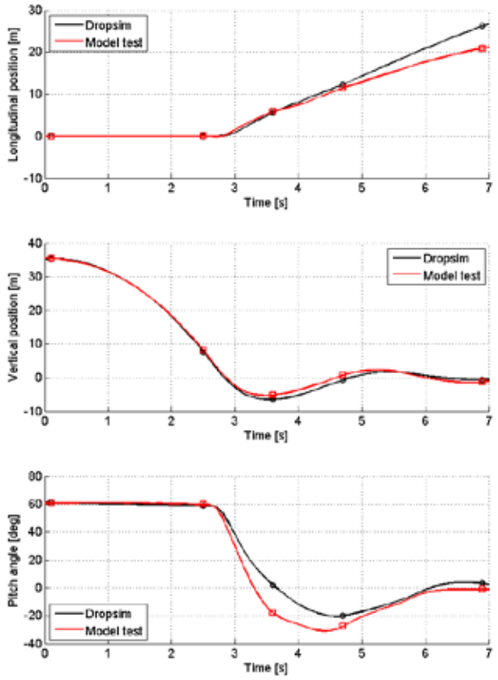
In the past four years MARIN has worked on a series of freefall lifeboat projects on behalf of the Norwegian Oil and Gas Association (NOROG), Statoil and lifeboat manufacturers. The latter, amongst others, includes the Dutch lifeboat builder Verhoef, which is also interviewed in this issue.

The main aim of the projects carried out together with NOROG and Statoil was to develop a transparent and consistent method to quantify the operability limits of lifeboats. To achieve this goal the software tool Dropsim was developed, which predicts the drop and sailaway behaviour of freefall lifeboats. The validation of Dropsim was successfully concluded at the end of September 2014. MARIN's work for the lifeboat manufacturers is to ensure that newly built lifeboats comply with the new standard of DNV – the DNV-OS-E406 – through model tests and full-scale trials.

Report highlights the work carried out in the past few years, focusing on the development of Dropsim, the dedicated lifeboat model tests and the full-scale trials.

Dropsim Model tests are a suitable means to quantify limiting wave conditions for safely launching a freefall lifeboat. A





Comparison of trajectories of a lifeboat during drop as found from model tests and simulations with Dropsim

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Water impact of bullet shape

large number of tests are, however, required to predict the behaviour for all the conditions the lifeboat may end up in. Dropsim is able to predict the behaviour of a freefall lifeboat during the drop, submerged, surfacing and sailing phases for a wide range of conditions.

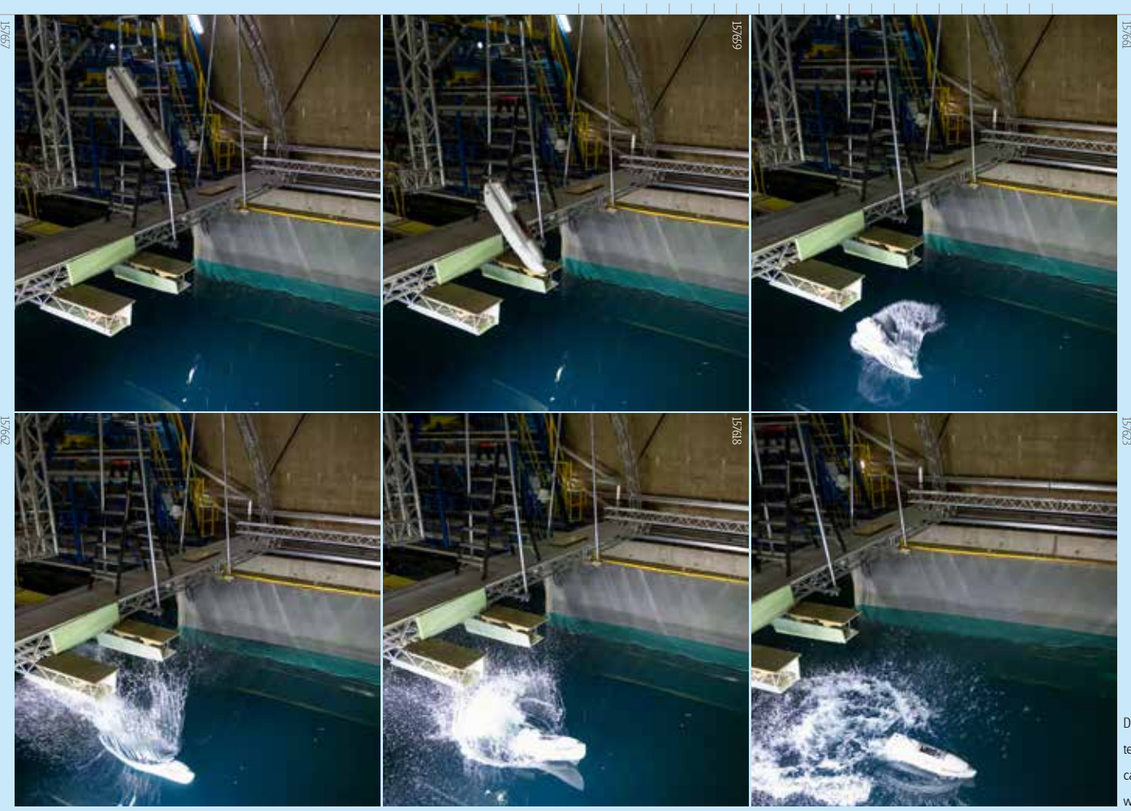
The mathematical model underlying Dropsim is completely non-linear and considers instantaneous submergence. All forces and moments in six degrees of freedom are calculated instantaneously, based on a summation of impact forces, cross flow drag forces, generated lift, Coriolis forces, as well as buoyancy, propulsion and steering forces and resistance.

As Dropsim is a simplified tool, it is vital to determine that the software is adequate for performing thousands of lifeboat drops, yielding robust predictions with sufficient accuracy. In order to show the performance of the simulation tool, an extensive validation procedure was established, based on the available model test data and data from other simulation tools. From this comparison, the accuracy of the predictions was determined and the program was validated.

Model tests As part of the lifeboat projects, a large amount of model tests were carried out in MARIN's Seakeeping and Manoeuvring Basin and Depressurised Wave Basin. The tests were used to study the behaviour of lifeboats in different (limiting) conditions, to show compliance of newly built lifeboats with the DNV standard and for the validation of Dropsim. Performed model tests included:

- Captive and free running manoeuvring and seakeeping tests
- Resistance and powering tests
- Integrated drop and sailaway tests
- Drop, water entry and exit tests with an elementary shaped lifeboat (bullet)

In particular the integrated drop and sailaway tests and the tests with the bullet-shaped model proved to be technically challenging and required dedicated test setups. During these tests, the model was completely free sailing and steered by an autopilot but completely autonomous by wireless control. An optical measurement system, which was installed flush in the hull of the model, was used to track the LED targets. Accelerometers inside the model and pressure gauges installed in the hull measured the accelerations and pressures, respectively.



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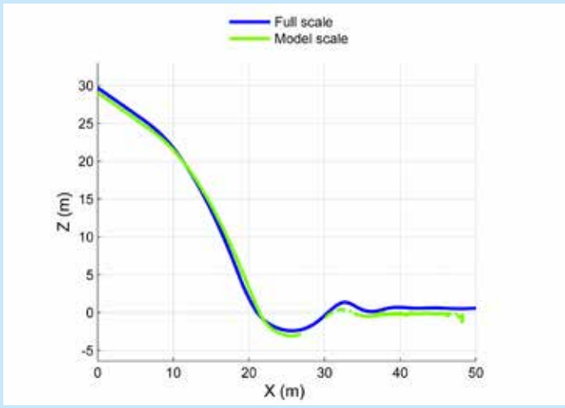
Drop test in calm water

Full-scale trials Newly built freefall lifeboats should comply with the DNV-OS-E406 standard, which requires full-scale prototype testing to document the lifeboat performance, in terms of forward speed and occupant safety amongst other things.

MARIN has assisted lifeboat manufacturers in performing full-scale drop tests in calm water and waves. Tests in calm water were conducted to show that the thrust capacity of the lifeboat is sufficient to maintain mean direction and sufficient speed. The goal of the tests in waves was to show that the lifeboat can get away in severe waves from different directions and to show correlation with Dropsim. Due to safety and practical matters related to harsh weather trials, tests were mainly done in waves with a significant wave height of up to 6 m. Dropsim was subsequently used to calculate forward speed performance in all other sea states. The main areas of interest during the full-scale drop tests were the accelerations at critical locations and the deflections of the hull and the canopy. MARIN applied its on board measurement system during tests, with which Norsafe's GES52 was dropped from the world record height of 66.8 m.

Another goal of the drop tests was to collect data for validation of analytical work and model- scale testing. The figure below shows a comparison between the trajectory of the lifeboat during a drop in calm water measured as part of full-scale and model-scale tests. As can be seen, the two trajectories correlate very well.

Ongoing work The work described in Report has led to the development of a transparent and consistent method to quantify the operability limits of lifeboats. MARIN would like to think it has made a significant contribution to safer evacuation procedures with freefall lifeboats. The methodology is currently applied to existing and new lifeboat types. Newly built freefall lifeboats - according to the DNV-OS-E406 standard - should be tested at full-scale prior to delivery. MARIN has played a role in supporting these trials with measurements of accelerations, deformations and the trajectory of the lifeboat.



Comparison between the trajectory of the drop in calm water on full and model scale